

# **X/Ka-BAND DUAL FREQUENCY HORN DESIGN**

Jacqueline C. Chen\* and Philip H. Stanton  
Jet Propulsion Laboratory  
California Institute of Technology  
Pasadena, CA 91109

## **introduction**

The Deep Space Network has a need for a dual frequency horn for simultaneous dual frequency operation in a beam waveguide antenna. The dual frequency horn will receive X-band (8.4-8.5 GHz), KATANA frequency (33.6 -33.8 GHz), and DSN Ka-band downlink (31.8 -32.3 GHz) signals simultaneously. The horn is designed to receive circularly polarized waves. Low loss (noise) in the dual frequency horn is a prime consideration since the horn is employed in the reception of signals from deep space.

## **Analysis and Design**

The geometry of the dual frequency horn is a disk-on-rod inside a common aperture horn (Figure 1). The X-band signal is guided by the corrugated horn, then enters the four X-band ports. The X-band junction consists of four rectangular ports intersecting a cylinder. Two X-band ports are located 180 degrees apart in order to cancel out the higher order modes generated at this junction. A second pair of ports; located 90 degrees with respect to the first pair of ports, are necessary for circular polarization [1]. The Ka-band signal is guided by the corrugated horn then captured by the disk-on-rod, which guides the signal passing the X-band junction for high isolation. Since the disk-on-rod is lossy, it should be as short as possible, yet long enough to make the Ka-band signal travel past the X-band ports. The disk-on-rod ends in a straight corrugated circular waveguide section in order to prevent the generation of higher order modes at Ka-band. The disk-on-rod is designed to be electromagnetically invisible to the X-band.

The disk-on-rod inside a corrugated horn is considered as a series of coaxial waveguide sections and circular waveguide sections. The junctions between these waveguide sections are classified in the following three categories: coaxial-to-coaxial, coaxial-to-circular (or circular-to-coaxial), and circular-to-circular waveguide junctions. The electromagnetic field is represented by coaxial waveguide modes in the coaxial region and circular waveguide modes in the

circular waveguide region. By applying the mode matching method at the junctions, the scattering matrix of a disk-on-rod inside a corrugated horn may be achieved [2-3]. A computer program was developed based on the mode matching method to calculate the scattering matrix. Then the radiation pattern was achieved from the modes at the horn aperture. The radiation patterns of X-band and Ka-band are shown in Figures 2 and 3 respectively.

The radiation patterns of the dual frequency horn then are run through the DSS-13 beam waveguide system using Physical Optics analysis. The beam waveguide antenna includes three curved mirrors, three flat mirrors, a main reflector and a subreflector. The G/T values of the dual frequency system in the beam waveguide antenna are better than the G/T value using two horns and a dichroic plate to perform frequency separation assuming horns in both systems are cooled.

## Conclusion

An analysis of the X/Ka-band horn design shows good performance. Fabrication of a prototype horn is in process, to be followed by measurements in the beam waveguide antenna.

## Acknowledgment

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## References

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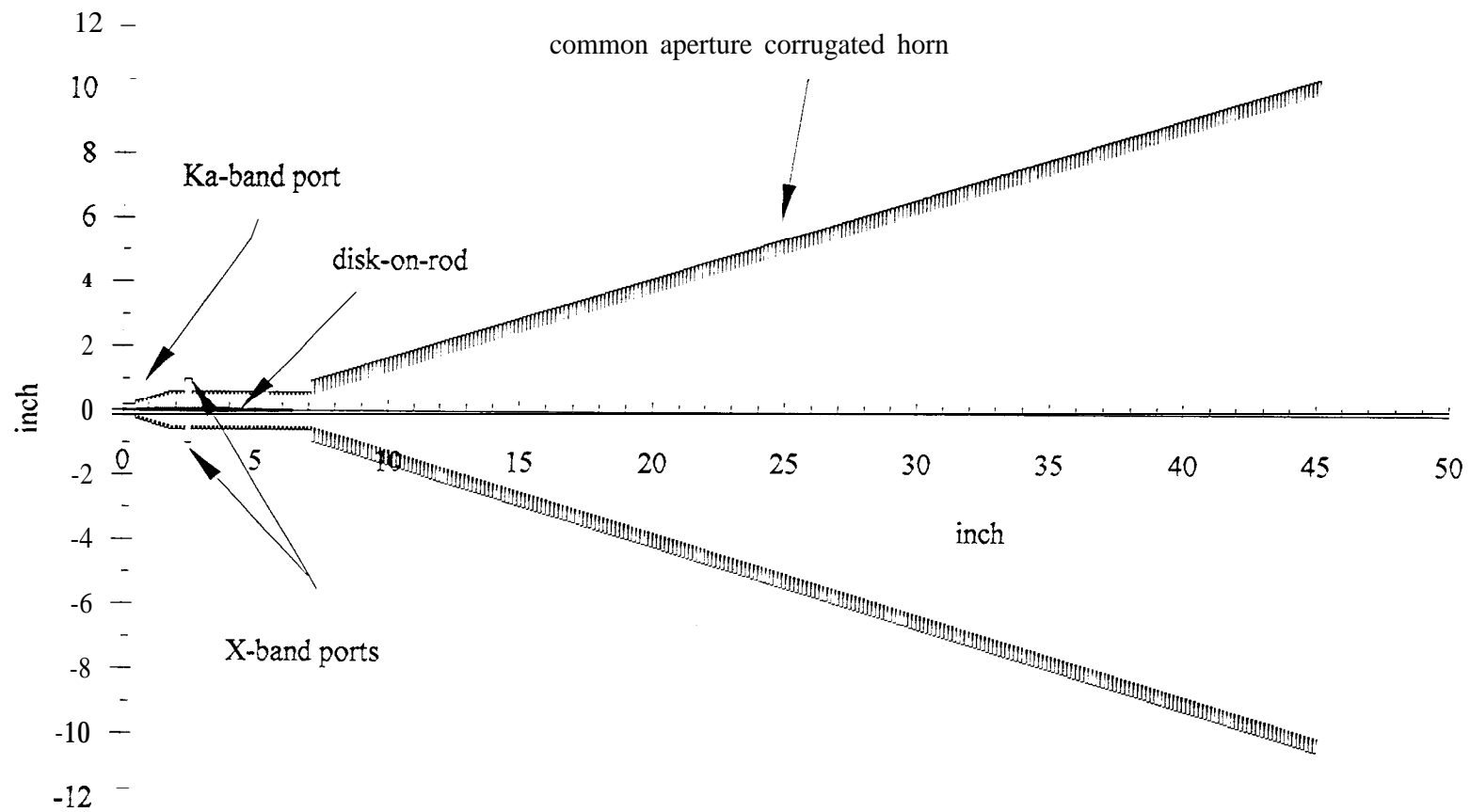


Figure 1. X/Ka-band dual frequency horn

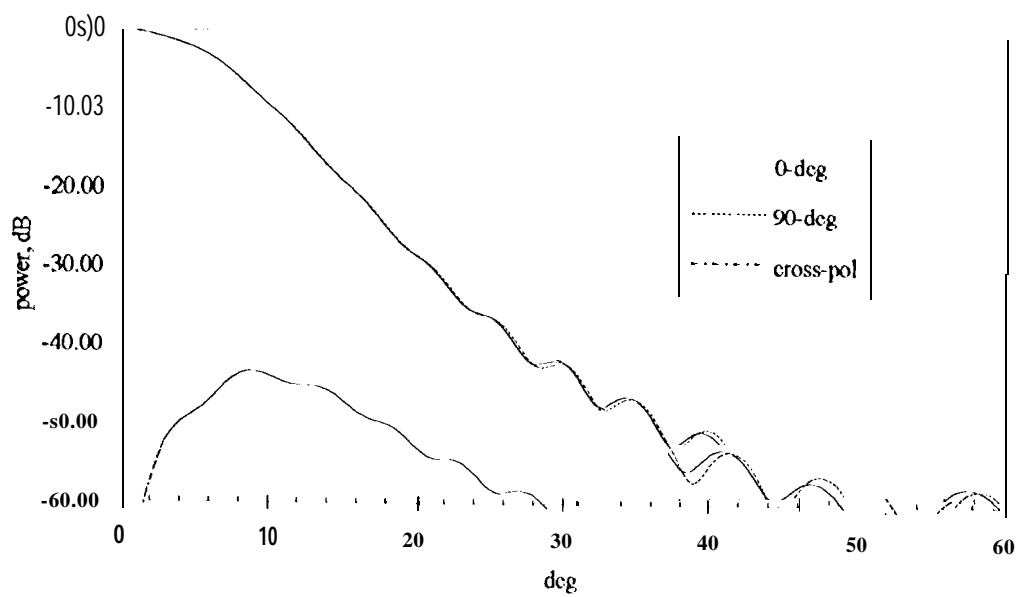


Figure 2. The radiation pattern of X/Ka-band dual frequency horn at 8.45 GHz.

